A LOCKING DEVICE OF A CLOSURE WITH A HOUSING

This invention relates to the locking device of a closure with a housing, particularly of a laboratory centrifuge.

Laboratory centrifuges require to be safely locked when in operation in order to avert dangers of accident caused by a contact with the rotor rotating at a high speed or with content which is centrifuged out. A safe locking device of a closure is also necessary in many other devices to which the invention relates as well. For example, this applies to the front flap of a washing machine or the trunk lid of a motor vehicle.

From EP 0 952 385 A2, a safety lock for lids has been known, particularly for centrifuges, wherein at least one holder element is passed through the lid underside and is releasably attached within the housing.

The holder element designed in a hook shape can be pivoted by means of a strip handle that it partly grips in a positive way around a closing bolt within the housing. When the lid is in a closed condition a locking pin positively engages a notched pawl of the holder element as long as the rotor rotates. The locking pin is moved into or out of the notched pawl via an actuating element which is driven via the device control in dependence on the working order. Actuating the holder element manually involves an expenditure of force and, moreover, the holder element permanently projects from the lid underside.

Furthermore, EP 0 154 983 A2 has made known a device to keep closed the door of a centrifuge wherein several hydraulic or pneumatic hook elements adapted to be moved into a locking position and an opening position are mounted on the centrifuge housing which when in the locking position engage receiver elements which are mounted on the door which is to be kept closed. The receiver elements also are of a hook shape and permanently project beyond the lid underside. The

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movable hook-shaped elements are pivotally supported on an axle fixed to the housing and project beyond the outer housing edge even if the door is opened.

Generally, manually operable locking devices of lids or other closures require a relative large expenditure of forces in closing and sealing the lid. The known locking devices will close here only if the lid is kept in a closing position where a sealing element which possibly exists requires to be elastically squeezed. Moreover, the known locking devices exhibit hooks or eyelets protruding beyond the housing or the lid, which impede their use or may cause accidents.

Accordingly, it is the object of the invention to provide a locking device of a closure with a housing, particularly a type designed as a lid locking device of laboratory centrifuges, which exhibits an increased operational comfort and is adapted to avoid locking elements which project beyond lids or housings.

This object is attained by a locking device having the features of claim 1. Advantageous aspects of the locking devices are indicated in the sub-claims.

The inventive locking device of a closure with a housing, particularly of a laboratory centrifuge, comprises

- at least one swiveling lever pivotally supported about an axis of rotation in the housing including a projecting guide element,
- at least one drive to pivot the swiveling lever about the axis of rotation,
- at least one catch hook supported on the swiveling lever at a spacing from the axis of rotation on a pivot axis which, at a radial spacing from the pivot axis, has a cam segment concentric thereto, into which the guide element of the swiveling lever engages,
- at least one spring means biasing the catch hook in the closing direction until the guide element bears against a first final stop of the cam segment, and
- at least one closing edge adapted to be gripped over on the closure so that if the catch hook is in an opening position and the swiveling lever is pivoted in the closing direction the spring means holds the catch hook with the first final stop

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on the guide element in order to pivot the catch hook with the swiveling lever in the closing direction and, if the catch hook impinges on the closing edge and the swiveling lever continues to be pivoted in the closing direction the guide element will move, within the cam segment, to a second final stop thereof, wherein the swiveling lever moves the pivot axis with the catch hook in the closing direction of the closure and, thus, the catch hook pulls the closure into the closing position.

In this locking device, the locking procedure is broken up into two phases:

In the first phase, the catch hook is pivoted with the swiveling lever until it impinges on the closing edge of the closure. Then, the second phase begins in which the swiveling lever moves the catch hook downwards and, thus, pulls the closure into the closing position. Such kinematics makes it possible to arrange the swiveling lever, in the aperture position, so as to be completely pivoted into the housing and to form the closing edge on an element which is accessible from the underside of the closure, but does not project therefrom. This means that the housing or the closure do not have projecting elements that are annoying or apt to cause accidents. In addition, the locking device is of a high operational comfort because a substantial expenditure of force in closing and sealing the closure is unnecessary. The kinematics permits to grip the closure with no need for it to be completely closed. At this point, the locking device constitutes some sort of kinematic sensor which pulls the closure onto the seal or into a closing position if the catch hook impinges on the closing edge of the closure. This motion of the closure can also be performed by means of the swiveling lever, at a reduced expenditure of force.

According to an advantageous aspect, the swiveling lever may substantially be of a circle segment shape which, in particular, provides a large-surface rest for the catch hook and possible mountings for the guide element and the pivot axis. According to a advantageous further aspect, the axis of rotation is disposed in the inner angular range of the circle segment shaped swiveling lever. A advantageous

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further aspect provides for the pivot axis to be disposed in the vicinity of a lateral limitation of the circle segment shaped swiveling lever. Besides, the external border of the circle segment shaped swiveling lever may be utilized to accommodate a series of teeth which interacts with a series of teeth of the drive. According to a further aspect, namely, the swiveling lever may have such a series of teeth on a marginal area extending around the axis of rotation in a circular arc shape.

According to a further aspect which is particularly simple, the guide element is a guide pin projecting from the swiveling lever. The guide element may be disposed at a spacing from the axis of rotation for supporting the swiveling lever. According to an advantageous aspect, however, the guide element is defined by a prolongation of the axis of rotation for supporting the swiveling lever.

The drive of the swiveling lever basically may be a manual drive. According to an aspect, however, a maximum operational comfort is achieved by the fact that the drive is by an electric motor. The fixation of the catch hook in the closing position may be caused or enhanced by a self-locking device or an additional blocking device of a driving transmission. As a blocking device, a driving motor may have a circuit which enables a short-circuit of the driving motor in the locking case in order to enhance the self-locking device action thereof. However, there can also be a blocking device mechanically engaging the driving transmission, which can be realized in a relatively easy manner because of the self-locking action thereof.

According to a practical aspect, the catch lever may have a widened base in which the pivot axis is supported and which, between the pivot axis and a neck with the hooked end of the catch hook, includes the cam segment. Furthermore, the catch hook may have a fixing point for the spring element between the cam segment and the hooked end. The spring element may particularly act between the catch hook and the swiveling lever. According to an advantageous further aspect, however, it will be active between the catch hook and a fixed point on the housing.

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The catch lever is adapted to be moved through a slot-shaped aperture in the upper side of the housing, which enables the catch lever to be displaced perpendicular to the upper side of the housing and parallel thereto. Basically, the locking device may be disposed so that the catch lever always projects approximately beyond the upper side of the housing. Particularly advantageous, however, is an accommodation in which the catch lever, in an opening position, does not project beyond the upper side of the housing.

Basically, the closing edge may also be accommodated on a projecting element of the closure. According to a particularly advantageous further aspect, however, the closing edge is in a region thereof which stands back with respect to the underside of the closure.

Basically, the locking device is suited for closures which are led to the housing in any motion desired. Particularly advantageous, however, is the locking device of a closure pivotally supported on the housing. It is preferred that the locking device be mounted at a spacing from the swivel bearing of the closure. In any case, one or more locking devices may exist for the closure. A single locking device may be sufficient, however, particularly in a pivotally supported closure.

According to another aspect of the invention, in a pivotally supported closure, however, the catch hook may impinge its hooked end on the closing edge in a pivoted position of the closure which is merely a few angular degrees. Then, the closure may only be pivoted so as to close approximately in order to create the prerequisite for a locking device. If the closure continues to be pivoted so as to close more this causes no harm because it will then also be ensured that the catch hook impinges on the closing edge, thus initiating the pull of the lid into the closing position.

According to an advantageous further aspect, the closure is pulled by the catch hook against a seal between the closure and the housing.

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According to a particularly advantageous further aspect, a self-locking action of the closing mechanism in the closing position may be achieved by the fact that the pivot axis, in the closing position, has been moved beyond a straight line extending through the point of rest of the hooked end on the closing edge and through the guide element.

Finally, according to an advantageous further aspect, the device may have several catch hooks. These preferably are seated on spaced-apart housing portions in order to lock the closure as safely as possible. It is preferred that different catch hooks be disposed on different swiveling levers each of which may have a drive or driving motor of its own. The different swiveling levers, however, may also be connected to a common drive, e.g. via a shaft. Besides, it is possible to place several catch levers onto various sides of the swiveling lever in order to grip over each closing edge twice.

The invention will now be explained in more detail with reference to the accompanying drawings which show one embodiment. In the drawings,

Fig. 1 shows the locking device of a lid of a centrifuge in the opening position in a partial section through the lid and the housing;

Fig. 2 shows the same locking device while the catch hook impinges on the closing edge in the same view;

Fig. 3 shows the same locking device in a closing position in the same view.

The locking device is formed on a laboratory centrifuge including a housing 1 and a lid 2 pivotally supported thereon for closing an upper side aperture of the housing 1 through which a centrifuge rotor is accessible. The drawings merely show a portion of housing 1 and lid 2 which is disposed at a spacing from the swivel bearing of the lid 2.

The lid 2 has a circumferential border which projects downwardly. It is at least from the border inside opposed to the swivel bearing of the lid 2 that an

marginal portion 3 projects inwardly the inner border of which defines a closing edge 4.

In its horizontal upper side, the housing 1 has a slot 5 which extends in a direction transverse to the swivel bearing of the lid 2. The slot 5 starts approximately at the level of the closing edge 4 if the lid 2 is in a closing position and ends at a larger distance from the closing edge 4.

Within the housing 1, approximately below the slot 5, there are more parts of the locking mechanism which interact with the closing edge 4 and are depicted in greater detail below:

In a frame structure 6 fixed to the housing, a axis of rotation 7 is held transversely to the slot 5. This axis of rotation 7 pivotally supports a swiveling lever 8 which substantially is of a circle segment shape. The axis of rotation 7 is in the inner angular range of the circle segment shaped swiveling lever. In addition, the axis of rotation 7 projects beyond the illustrated side of the swiveling lever 8 in a portion which defines a guide pin 9. Further, the substantially circle segment shaped border of the swiveling lever 8 is provided with a series of teeth 10.

On the same side of the swiveling lever 8 on which the guide pin 9 projects, the swiveling lever 8 carries a projecting pivot axis 11. This one is on the limitation of the swiveling lever 8 which is in the left-hand side thereof in the drawing. The pivot axis 11 is disposed at a spacing from the axis of rotation 7 in the vicinity of the series of teeth 10.

The pivot axis 11 supports a catch hook 12 having a base 13, which substantially is of a circle segment shape as well. At this point, the pivot axis 11 is in the inner angular range of the base 13. Near the outer border of the base 13, the catch hook 12 has a cam segment 14 which is concentric to the pivot axis 11 and is engaged by the guide pin 9.

The catch hook 12 further has a neck originating from the base 13, which carries a hooked end 15. The catch hook 12 is adapted to be moved in a vertical

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plane extending through the slot 5 where it particularly may bring its hooked end 15 in engagement with the slot 5 or may grip through the slot 5.

On the left-hand side in the drawing, the catch hook 12 has a bearing eyelet 16 on which a helical spring 17 is supported. The other end of the helical spring 17 is held on a bearing point 18 of the frame structure 6 fixed to the housing. The arrangement of the spring element 17 is such that it will be above the swivel bearing 11 in any position of the locking mechanism so that it always seeks to pull the catch hook 12, in a counter-clockwise sense, into a position in which the guide pin 9 strikes against the first final stop 14', the right-hand one in the drawing, of the guide cam 14.

Finally, the locking mechanism has an electric driving motor 19 which also is firmly supported on the housing and has a rotary driving gear 20 whose series of teeth meshes with the series of teeth 10 of the swiveling lever 8.

The locking devices operates as follows:

In the opening position shown in Fig. 1, the driving motor 19 has pivoted the swiveling lever 8 clockwise about the axis of rotation 7 until a final position is reached in which the gear 20 approximately has reached the one end of the series of teeth 10. In this position, the biased helical spring 17 pulls the catch hook 12 counter-clockwise so that the guide pin 9 abuts against the first final stop 14 of the cam segment 14'.

To close the lid 2, this one first is manually pivoted to the housing 1 until it gets into an angular position of about 5° with respect to the housing 1, which is shown in Fig. 1.

To lock the lid 2, the driving motor 19 drives the swiveling lever 8 about the axis of rotation 7 in a counter-clockwise direction. The helical spring 17 causes the catch hook 12 to continue abutting its first final stop 14' against the guide pin 9. Consequently, the catch hook 12 is pivoted along about the axis of rotation 7 with its hooked end 15 exiting from the upper side of the slot 5. The catch hook 12 is

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pivoted along until its hooked end 15 impinges on the closing edge 4 of the lid 2 as is shown in Fig. 2.

As soon as the catch hook 12 impinges on the closing edge 4 this one becomes the new fulcrum of the catch hook 12. If the swiveling lever 8 continues to be pivoted counter-clockwise the catch hook 12 consequently is pulled downwardly on the pivot axis 11 and the guide pin 9 in the cam segment 14 is moved towards the second final stop 14" which is the left-hand one in the drawing. The downward motion of the catch hook 12 causes the lid 2 to be pulled against the upper side of the housing 1 over the closing edge 4 and, hence, to be closed. The closing motion ends when the gear 20 approximately has arrived, in a clockwise sense, at the outermost end of the series of teeth 10. Then, the swivel bearing 11 has been pivoted by the closing edge 4 and the guide pin 9 beyond the prolongation of a straight line, which results in a self-locking effect. At this point, the guide pin 9 preferably bears against the second final stop 14" of the cam segment 14. Basically, however, it is also possible that the guide pin 9, in a closing position, does not reach the second final stop 14".

Another contribution to a self-locking action is achieved by means of the driving transmission. Further, the electric driving motor 19 is shortcircuited with a view to securing the catch lever 12 in the closing position of Fig. 3.

To unlock the lid 2, the driving motor 19 is operated in a reverse sense so that the course of operations described above is performed in an inverse direction.